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JUDITH SPARER, MS, CIH

## ENVIRONMENTAL EVALUATION OF WORKERS WITH MULTIPLE CHEMICAL SENSITIVITIES: AN INDUSTRIAL HYGIENIST'S VIEW

According to a standard and widely used reference,<sup>1</sup> the charge of traditional industrial hygiene is to protect "nearly all workers." Guidelines are specified "to represent conditions in which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect." The handbook goes on to say that some workers may experience discomfort at concentrations of some substances below these threshold limit values (TLV's) and even fewer may be affected more seriously because of a pre-existing condition or by development of an occupational illness.

In recent years the issue of the "nearly all workers" has been raised and several articles have been published addressing the question of who those others are and what should or can be done about them.<sup>2-6</sup> The thrust of these articles is that there are subpopulations whom it is either impossible or impractical to protect but who could be identified, advised of their risk, and either followed until they develop clinical problems or are denied employment in what for them would be a hazardous environment. Although undoubtedly there are many clinical reasons for such individual responses, workers with multiple chemical sensitivities are certainly among those who would fall into that "other" group of reactors at the extreme low end of the dose-response curve.

Because of drastic implications of arbitrarily assigning such workers to an "unprotectable" status, it is crucial that each individual's environment(s) be carefully explored and evaluated to establish where on the appropriate dose/response curve or curves they sit. As I shall try to demonstrate, these patients may be far more protectable than initially imagined if the work-up is performed in the appropriate way and if those who control the environment—usually the employers—are willing to be open-minded and flexible in their interpretation of the results. Premature labeling may obscure documentable environmental disease and lead to complacent acceptance of a work environment that may be hazardous to many more workers than the hypersensitive individual whose extreme symptomatology forces the issue into the open.

To put this in practicable form, I shall begin with a presentation of the basic

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Occupational Medicine Program, Department of Internal Medicine, Yale University School of Medicine, New Haven, Connecticut

Reprint requests to Judith Sparer, MS, CIH, Occupational Medicine Program, School of Medicine, 333 Cedar Street, New Haven, CT 06510

approach to the worker environment. Subsequently, some of the subtleties and difficulties will be described by analyzing some of our more challenging cases.

## THE GENERAL APPROACH

### INFORMATION OBTAINABLE FROM THE PATIENT: HISTORY

It is useful to begin with an occupational history, starting with the current or most recent job and going back as far as possible to get the shape of the person's working life. Find out the job title and something of the working environment at each job. What did the person actually do? Was there any chemical or dust exposure? Did he/she work in an industrial environment or an office environment?

Then focus particular attention on the time period of onset of symptoms. Make sure that you understand what the person's job actually was. What was the function of the place of business (i.e., did thy make widgets or provide legal services?). What products, chemicals, materials were handled and for how much time of the person's time? Was/is there appropriate ventilation? Did any changes at all occur at the workplace? Were new chemicals introduced? New processes or machines? Was any renovation done in the office? New carpeting? Did the trouble arise subsequent to a flood or modification of the ventilation or heating systems? Any change that can be associated with that time period may be a valuable clue. Of course, patients do not always know the answers to all of these questions, and access to information may require some effort on the patient or practitioner's part; general approaches are discussed below.

The same kind of information about non-work environments must be obtained, focusing again on the changes that may have occurred prior to or during the beginning of the illness. Any renovation in the home, pest extermination, or insulation may be important. A move or a change in detergent used, a new hobby practiced or other forms of activity should be noted. Usually the patient should be able to provide these data, though it may require some thought and/or review of household products and practices.

The temporal behavior of the illness may also yield valuable environmental clues. The pattern, if one can be identified, of feeling sometimes better and sometimes worse can point toward specific offending environments. For example, symptoms that emerge during the work week and resolve on weekends—a "better at home and worse at work" story—is helpful. Or, "Since moving to the new house, I haven't been able to breathe!" Care must be taken, though, not to "beg" associations nor to equate automatically temporal with causal relationships.

Patient perception of the "epidemiology" of the problem may also be valuable and should be elicited. Do other people at the workplace have the same problems? If the answer to this question is yes, it is more likely that a common environmental problem, rather than special or unique host factors, is causal. Importantly, such patients may be the key to recognition of "indoor air pollution" or "tight building

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"syndrome" outbreaks. If the patient feels others tolerate his/her environment without symptoms, there may still be an indoor air pollution problem but one that will be more difficult to resolve. One must remember, too, that the complainant may have become so socially isolated by his or her illness that knowledge about the reaction of others has been obscured.

¶ Where possible, the names of specific environmental contaminants should be elicited. Information sheets, called Material Safety Data Sheets (MSDSs), should be available through workplaces and product manufacturers. As of 1986, these MSDSs are required by the Occupational Safety and Health Administration to be available to employees in the manufacturing sector but are now often obtained in the service sector as well. These sheets should identify the toxic components of all materials used in the workplace, giving generic chemical names for ingredients in everything from carpet shampoo to roach spray to widget oil. Without fairly complete information of this sort it is very difficult to pursue the possibility that certain specific exposures may be causing symptoms. Unfortunately, these sheets are not always filled out thoroughly or informatively, i.e., a certain portion of the compound may be listed as "proprietary" or "inert." You may have to call the supplier at the number that should be on the MSDS for more useful information. It will usually be supplied to a physician without objection.

Of course, in order to make sense, this information must be evaluated in the context of the patient's job and practices—how often the chemicals are used, in what proximity to the persons' workstation, etc. Carpet shampooing may be done once a year or once a week. Similarly, a toxic degreasing fluid may be sitting in an open tank on a workbench or may be carefully enclosed and equipped with local exhaust ventilation, a very big difference.

The answers to all these questions provide the basis for subsequent steps, but not always sufficient information to determine whether specific environmental cause(s) can be found to explain symptoms. Occasionally, results of clinical evaluation may be revealing of a specific toxic effect, focusing all further attention on a particular chemical or operation. In patients with complaints of multiple chemical sensitivities, however, this is rarely the case. Usually the environment itself must be investigated further. This is the subject of the next section.

## EVALUATION OF THE PATIENT'S ENVIRONMENT

Partly because of tradition, and partly due to the regulatory environment in which we are taught to function, industrial hygienists often tend to approach the environment by first attempting to categorize and to quantify its contaminants. Usually this is done without detailed knowledge of the clinical complaints that may have prompted the investigation nor any epidemiologic information suggesting relationships between the workplace and complaints.

In evaluating the environment of individuals with multiple complaints this approach can be misleading, since it almost invariably leads to the premature conclusion that exposures are "too low" to be causing effects. This circumvents the real issue—whether identifiable or correctable low level exposures may be

causing the problem—and may lead the patient and the employer alike into polarized, intransigent views of what is going on. The following case illustrates these problems:

**Case 1:** We were asked by the administration of a nearby hospital to investigate the case of a supervisor with multiple symptoms that she associated with "the air" in her billing office. Her problems included skin and eye irritation, cough, congestion, and extreme fatigue associated with work. Significantly, other workers in the room also had similar complaints. Steps taken included physical exams for those most affected (which were unrevealing), a "gambit" move of the office to a room down the hall, isolation of old files in a remote room, and the initiation of renovation of the former office space. These changes failed to alleviate the complaints. An environmental consultant was hired to investigate.

The consulting firm sampled air for fiberglass, suspected to be entering the ventilation system from renovation of an adjacent wing of the building. They also sampled for formaldehyde, nuisance dust, ozone, carbon dioxide and organic solvents, "the usual suspects." Carbon dioxide was found to be 600-700 ppm. Others were not found at detectable levels. A general sample of organic solvents revealed only "common solvents at levels significantly below industrial hygiene concern." Later, marked variations by location in organic solvent levels, all well below those levels, were documented by the same consultant.

Based on these results, the employer assumed that no serious environmental hazard existed and attempted to disclaim the problem. Unfortunately, this infuriated the affected employees and symptoms were aggravated. Some months later our group was called for a second opinion.

Consistent with our general approach, we began our work with a simple symptom questionnaire, including an open-ended question to determine what each respondent thought was causing the problem. A second billing office where there were no reported "cases" was used as a control group, allowing us to calculate attack rates and determine that there was a clearly worse than normal situation in the affected department. This epidemiologic fact, as well as the association between symptoms and time spent in the office, was central to our subsequent look at the environment itself. Specific sources of odor or symptoms reported by the patients were also noted. Not unimportantly, we learned that most symptoms had begun only after the onset of a major building renovation.

We next conducted a walk-through of the offices, paying close attention to possible sources of noxious dust or fumes, stressful or harmful work practices and the ventilation. We discovered clear evidence of various construction dusts and fiber throughout the office, several sources of unusual potential contamination, especially carbonless copying forms, and a ventilation system set to recycle office air rather than introduce fresh air. Furthermore, smoking was allowed throughout the area; stale smoke filled the room. Finally, it was apparent that the noise and inconvenience of the external renovation was stressors inside the office, as were the impressive numbers of forms.

We concluded that there was an environmental problem, the multi-faceted causes of which included fiberglass and other construction dust, off-gassing from the carbonless copy paper forms, cigarette smoke and lack of fresh air. No further "measurements" were proposed and findings and recommendations were presented to both management and all the employees. Recommendations included clean-up of the fiberglass, air balancing and the provision of increased fresh air to the area and better mixing, the dedication of a separate smoking area, and strong encouragement for the company's plan to drastically reduce the mountains of forms by switching to a computer system. With these recommen-

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dations came our assurances that there was no evidence that the present problem would increase the risk of developing disease later on as a result of these exposures.

The follow-up is illuminating. Six months later construction was still going on, the amount of fresh air was claimed to be about 33%-100%, smoking was not permitted, fiberglass and dust were no longer present but the mountains of forms were undiminished. The number of complaints were far fewer but the problems of the index case had become worse. With more experience, we realize that this is not an atypical case. Four years later, complaints continue, fresh air is claimed to be 100% but  $\text{CO}_2$  is still twice that of outside air.

As the above case illustrates, potential contaminant sources in the workplace are legion, even in an office, an environment historically considered clean, quiet and free of industrial toxins. An office environment will usually contain a copying machine that may use solvents in copy development or may generate significant amounts of ozone by the high voltages used. Office construction and new furniture may contain particle board emitting formaldehyde; plastics and electronic equipment with trace odors and cleaning compounds may be present. Habitation by people who breathe, work, smoke, and wear perfume in and of itself necessitates some ventilation to minimize irritant effects.

The mechanical ventilation system, in addition to possibly providing inadequate dilution and flushing with fresh air, may be the source or means of distributing the problem. It may be carrying chemicals or flue gases or dust from a remote area or even an outside source and bringing it to an otherwise clean area. It may be lined with fiberglass that is getting into the airstream. It may not be equipped with humidification, resulting in extremely low relative humidity. Less than 40% relative humidity causes severe discomfort to many people. Or it may contain moisture and carry bacteria or molds or other biologically active material into the work areas. Thus, even a seemingly innocuous work environment may be causing illnesses.

Very often environmental data regarding people with MCS will be interpreted out of the context in which they are developed by comparison to applicable OSHA or other industrial standards. In general, in nonindustrial settings pollutants will be identifiable at levels far below these standards. For example, although OSHA currently condones a level of 3 ppm of formaldehyde averaged over 8 hours, never to exceed 10 ppm for more than 30 minutes, levels as low as 0.05 ppm have been associated with persistent respiratory congestion and asthma in some individuals. Formaldehyde is an extremely irritating substance, easily perceived. Other chemicals, too, may cause these typical adverse health effects at levels well below the standards in some susceptible individuals. Consequently, the numbers themselves cannot be readily used to determine whether particular environmental factors may be causal of symptoms. Certainly formaldehyde in almost any quantifiable amount could, for some individuals, be a problem. Other factors are less well studied. Indeed, the effects of complex mixes of traces of many substances have not been studied at all. A lot of money can easily be spent for measurements only to find that nobody knows quite what to make of the results. Day-to-day variation can also be great; at very low levels the range can easily be an order of magnitude or

two! Conservatively, the presence of any chemical means it could likely be found at higher levels at other times. Thus, any substance present at levels of 1-10% of established TLVs should be traced to its source and eliminated or managed with local exhaust ventilation, if necessary. The bottom line is, though, that the cost to accurately define the distribution of all contaminants usually far exceeds the benefits. Even if such data could be readily obtained, they often fail to answer the question of causation of the patient's symptoms.

Far more useful than this sort of "fishing in the air" would be a few simpler measures directed toward a solution. Many people are now using carbon dioxide as a marker for the build-up of low-level contaminants. Carbon dioxide is present in the atmosphere at 300-350 ppm and is nontoxic. It is, of course, a by-product of combustion as well as breathing, and is regarded as an asphyxiant gas at 5000 ppm. At 500 ppm in an indoor environment some people report symptoms such as headache and fatigue. At 1500 ppm almost everyone complains. Other symptoms are also reported that may be due to other chemicals present but not measured. In general, any buildup from morning to afternoon is a marker for inadequate ventilation.

#### LOOKING AT THE VENTILATION

While quantifying levels of particular contaminants is frequently unrewarding, extensive assessment of general and local ventilation is often of major diagnostic and therapeutic importance. Bringing the ventilation system up to standard cures indoor air pollution problems in the vast majority of non-industrial workplaces. A review of the system to make sure it has been properly maintained, that fans are functioning as they should, that fresh air dampers are well placed away from contamination sources and sufficiently open is paramount. Then the amount of fresh air actually being delivered must be calculated. The American Society of Heating, Refrigerating and Air Conditioning Engineers has developed draft guidelines suggesting a minimum of 20 cubic feet per minute (cfm) of fresh air per person, to maintain a CO<sub>2</sub> concentration of less than 1,000 ppm. It has been recommended that new buildings be ventilated with 100% fresh air for the first 6 months and that recirculated air be limited to a maximum of 50% for the next 1-2 years because of off-gassing of modern building materials.<sup>3</sup>

Occasionally cases can be traced to specific causes such as algae in the humidifying system, or mold on a rug that had been flooded during a roof leak, or a carbonless copy paper recently introduced. Most often, a combination of strategies such as reducing sources, providing local exhaust ventilation, providing for better air distribution and mixing, removing mildewed carpet, cleaning heating coils or increasing the fresh air is successful.

To put these findings in perspective, the National Institute for Occupational Safety and Health has reported results of almost 450 non-industrial worksite investigations where one or more worker(s) complained of recurrent symptoms at work; in almost 90% some correctable problem was found<sup>5</sup>:

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1. Inadequate ventilation was cited in 52% of the cases. Among the problems were insufficient fresh air supplied, poor distribution and mixing, temperature and humidity extremes or fluctuations, and poor maintenance.

2. Inside contamination, including improperly applied pesticides, boiler additives such as diethylethanolamine, cleaning agents, tobacco smoke, combustion gases and cross-contamination from other locations was the major cause in 17% of the investigations.

3. Outside contamination caused 11% of the problems. This included motor vehicle exhaust, asphalt, solvents, dust and sewer gas that got access to the building through intake plenums, windows, or leaks.

4. Biological contamination was involved in 5% of the investigations. Fungi, bacteria, microbial products and even protozoa can be responsible.

5. In 3% of the cases, building materials such as particle board, fiberglass, glues, adhesives and caulking caused the problem.

## THE INDUSTRIAL ENVIRONMENT

The industrial environment presents very different problems to the industrial hygienist. I will illustrate with another case.

**Case 2:** Mr. G. came to our clinic shortly after recovering from pneumonitis, most likely due to an accidental exposure at work to various irritants, including H<sub>2</sub>S and phosphoric acid. As he recovered he noted the onset of respiratory and nervous system complaints to numerous chemicals, both inside and outside the workplace. Although exhaustive medical tests were negative, he was unable to work for over one year. He underwent both group and individual psychotherapy aimed at insight and diminishing symptom amplification; he was also placed on antidepressants for suspected associated depression.

As part of his rehabilitation, the workplace environment was evaluated. Recommendations were made, and because he was a senior and valued employee, modifications to reduce both daily exposures and the risk of accidental over-exposures were made. Mr. G. returned to his original job. Although he continues at the same factory, his work station has been changed and his exposures to chemicals are greatly diminished. Nonetheless, he continues to have recurrent episodes of respiratory distress accompanied by dizziness, but he is permitted fresh air breaks when he feels ill. Lost work time is minimal.

This case illustrates the great value of carefully exploring the environment even when nonenvironmental factors are also clearly important. Although the clinical staff treating Mr. G. suspected the importance of psychological issues subsequent to his accident, definition and manipulation of the work environment played a crucial role in his overall evaluation and treatment. The case also illustrates the importance of "individual" standards and practices for toxins when this is feasible; this patient was able to continue at a skilled job, preventing extreme personal dislocation and likely prolonged illness and disability.

## SOLUTIONS

Most professionals are trained in some specific methodology for problem-solving stemming from a universal assumption that the first essential step is to

define the problem. In occupational health, when we are unable, as often happens, to make such a definition with satisfactory specificity, one of two things happens: (1) We pour our resources into attempting to elucidate the problem, which is often doomed to failure because of the lack of sufficient knowledge. We keep looking for already identified and "proven" problem causers, which is as yet a severely under-populated category; (2) We define away the problem by concluding that the environmental conditions are "normal" or the incidence rate of illness is "acceptable," hence, no related illness exists. Once we have fallen into either of these two stagnant backwaters, we fail to work to improve conditions by implementing any of the routine measures to improve the environment, and we fail to contribute the understanding of the mechanism of response of those who suffer first and most.

Those affected can be identified with the help of the occupational history discussed earlier. Knowledge of exposure to potential toxins and patterns of illness in coworkers consistent with an environmental source make the likelihood of a correctable problem high. Although the role of specific factors in an individual case may be problematic, with a strong solution-oriented approach, persistence and cooperation, many MCS patients can be, if not completely cured, at least helped.

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